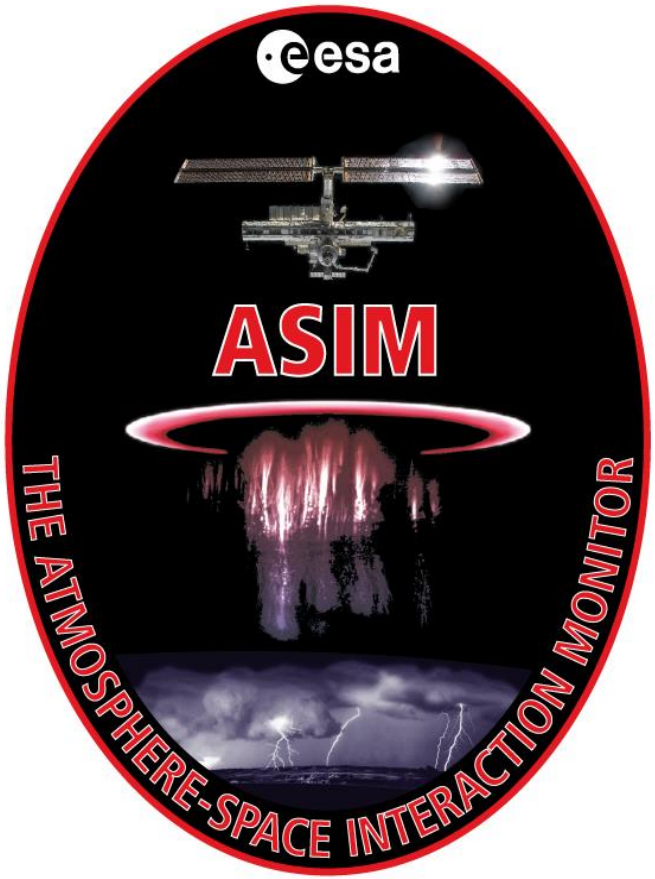
The ASIM experiment on the ISS

Torsten Neubert
and the ASIM Team

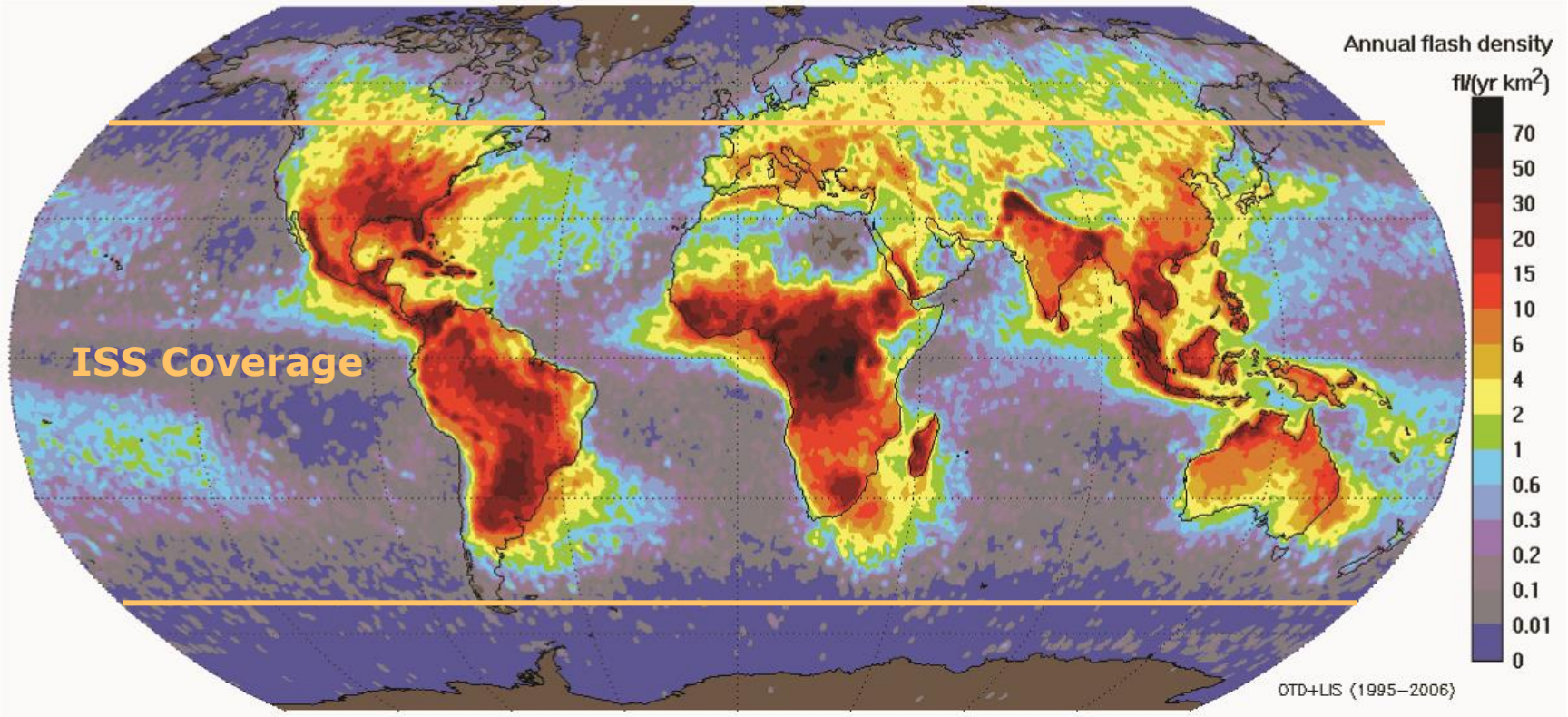


DTU Space
National Space Institute

Content

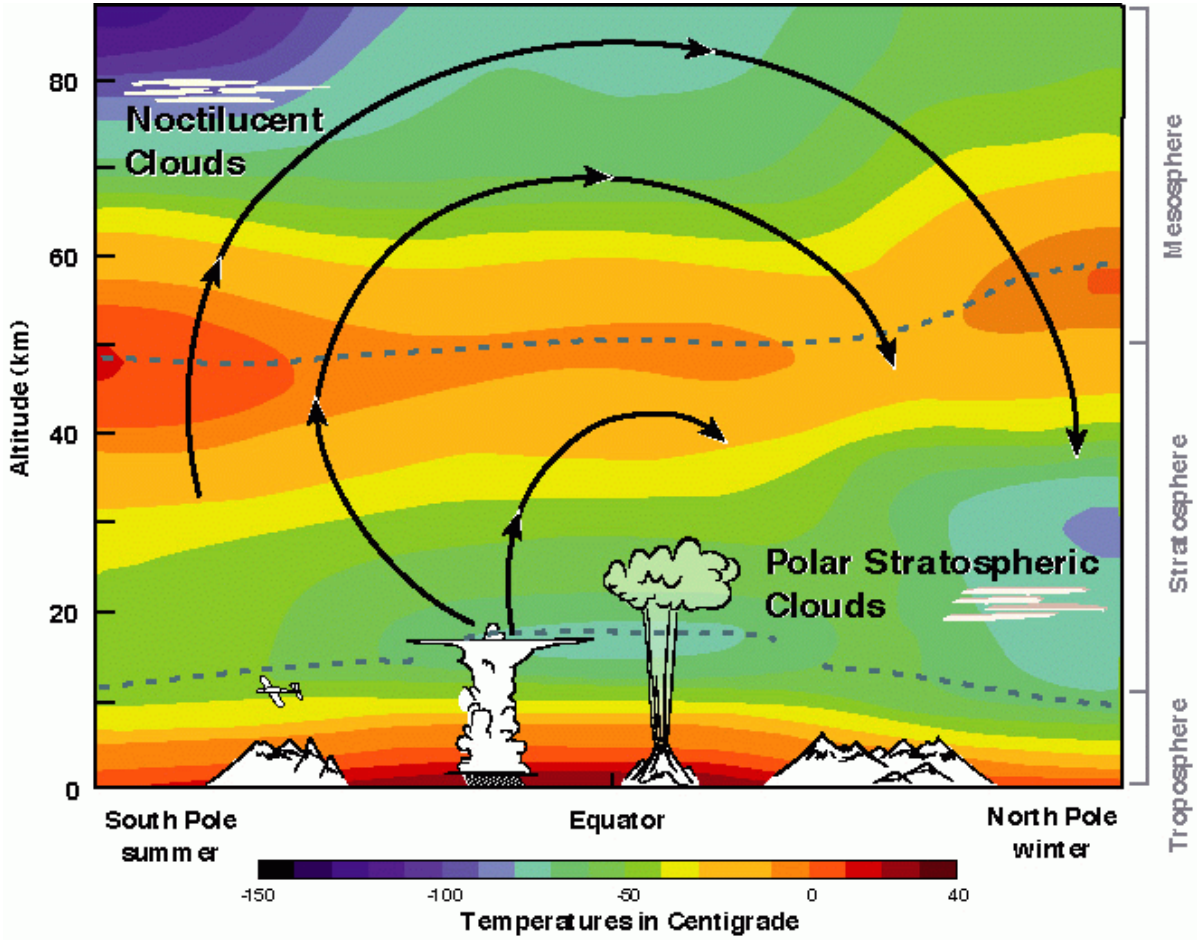
- The Science
- The ASIM Payload
- The Science Instruments
- Status and Consortium

The occurrence of lightning



LIS Data, Hugh Christian

The global transport

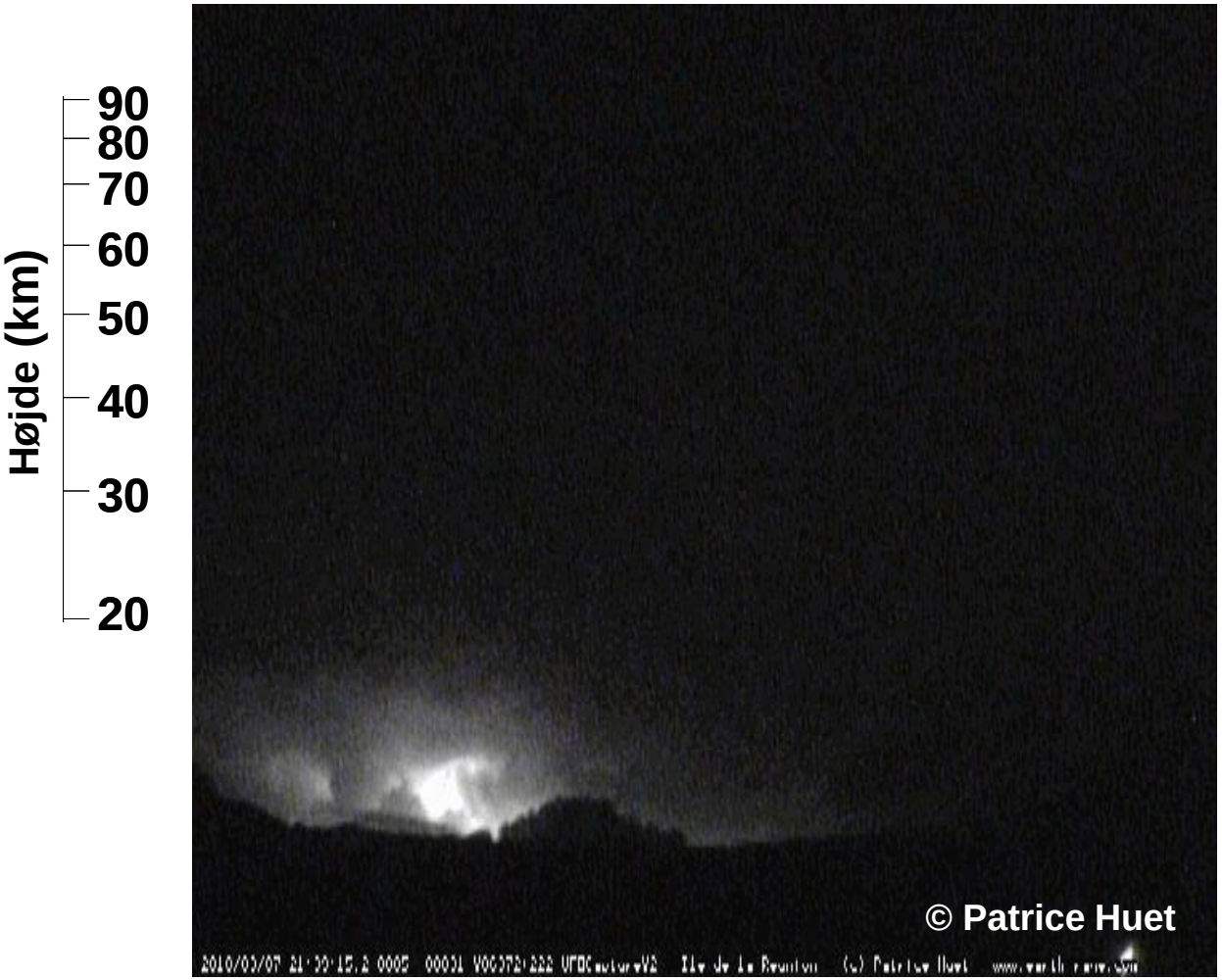


- Ordinary storms:
  - **horisontal** winds
- Thunderstorms:
  - **vertikal** winds
  - Make them electric
  - Transporterer dust and water vapor to high altitude.
  - The higher:
    - longer lifetime
    - larger area affected
    - larger overall effect

But what happens above thunderstorms?

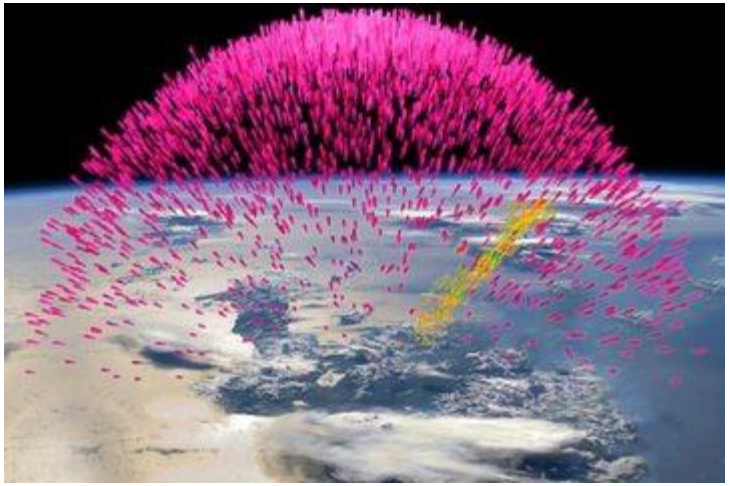
- Difficult to measure from ground, balloon and aircraft
- The mesosphere is also called the ”ignorosphere”
- Some satellite observations during recent years

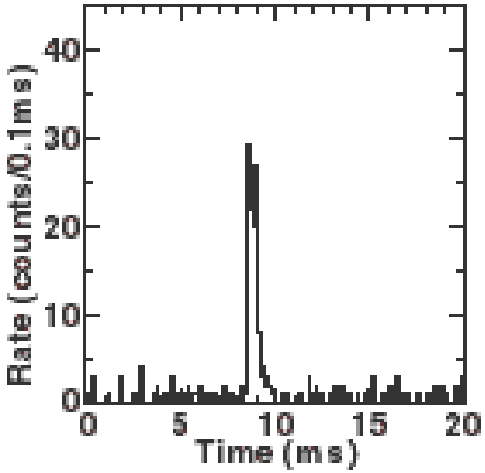
Giants – discovered in 2005



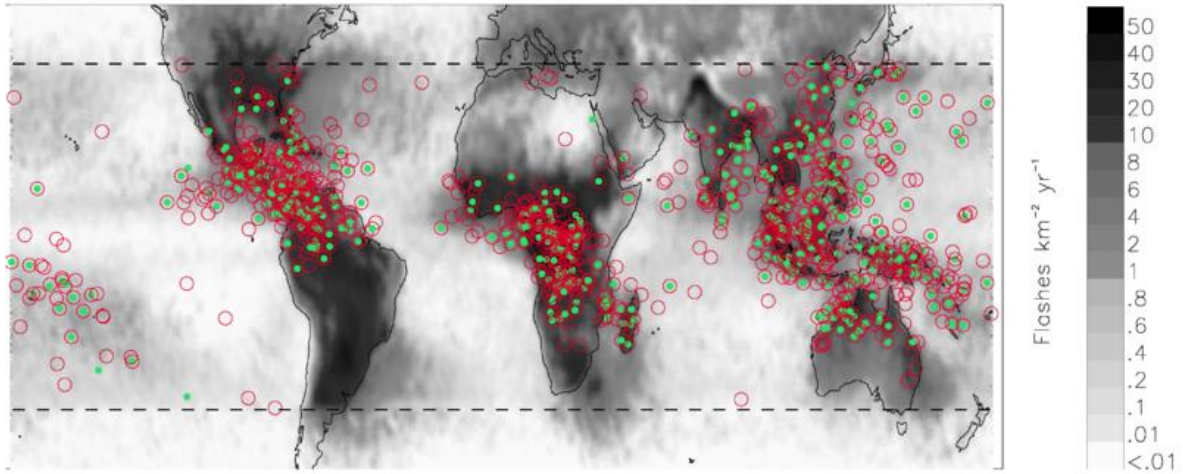
Serge Soula, J. Geophysical Research, 2011.

Terrestrial Gamma-ray Flashes TGF - 1994





Fishman et al. Science, 1994



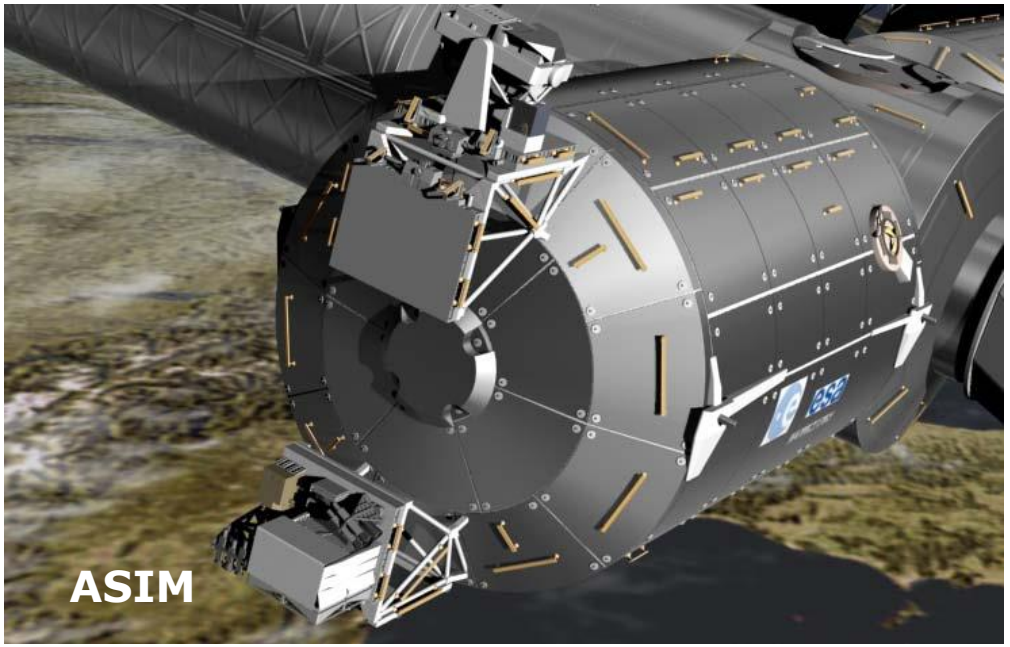
Gjesteland et al., JGR, 2012

ASIM Objectives

- To study energetic thunderstorm processes
  - X- and Gamma-radiation
  - Lightning from clouds to the ionosphere
  - Cloud and storm development
- To study Cosmic influences on the atmosphere
  - Lightning initiation stimulated by cosmic radiation
  - Meteor seeding of electric discharges in the mesosphere
  - Energetic particle precipitation from the magnetosphere (aurora)

The ASIM Mission

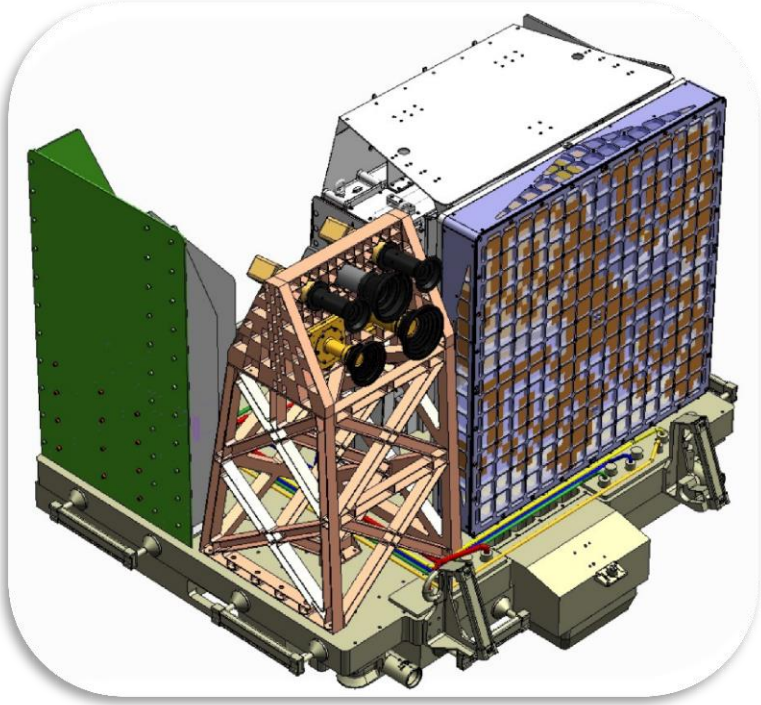
- ASIM will be launched by SpaceX Dragon to the International Space Station in 2016
- The instruments are mounted outside the ESA Columbus module pointing nadir
- Observations in bands that are absorbed in the atmosphere
- Consortium lead is Terma
- Funding from ESA and national sources



The Payload

- MMIA (The Modular Multispectral Imaging Array):
  - three photometers
  - two cameras

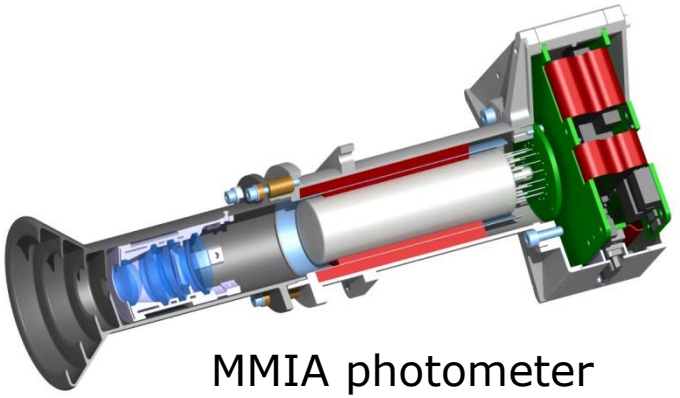
- MXGS (The Modular X- and Gamma-ray Sensor):
  - low-energy detector (LED)
  - high-energy detector (HED)



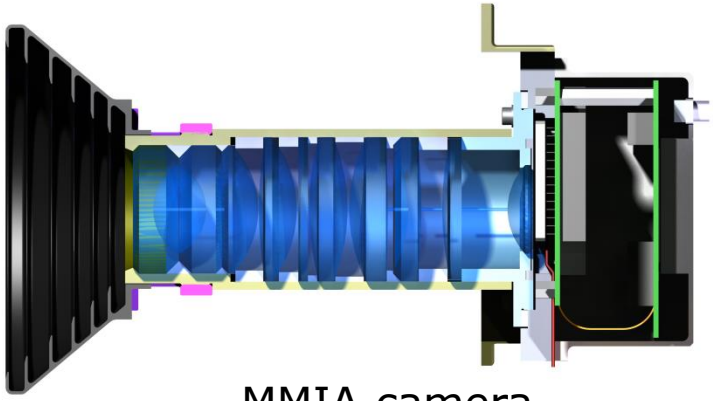
The MMIA

- Three photometers:
  - 180-250 nm
  - 337.0 nm/5 nm band
  - 777.4 nm/5 nm band
  - 100 kHz sampling

- Two cameras
  - 337.0 nm/5 nm band
  - 777.4 nm/5 nm band
  - 1 M-pixel
  - 400 m resolution
  - 12 frames/sec
  - event detection software
  - e2v CCD with on-chip amplification



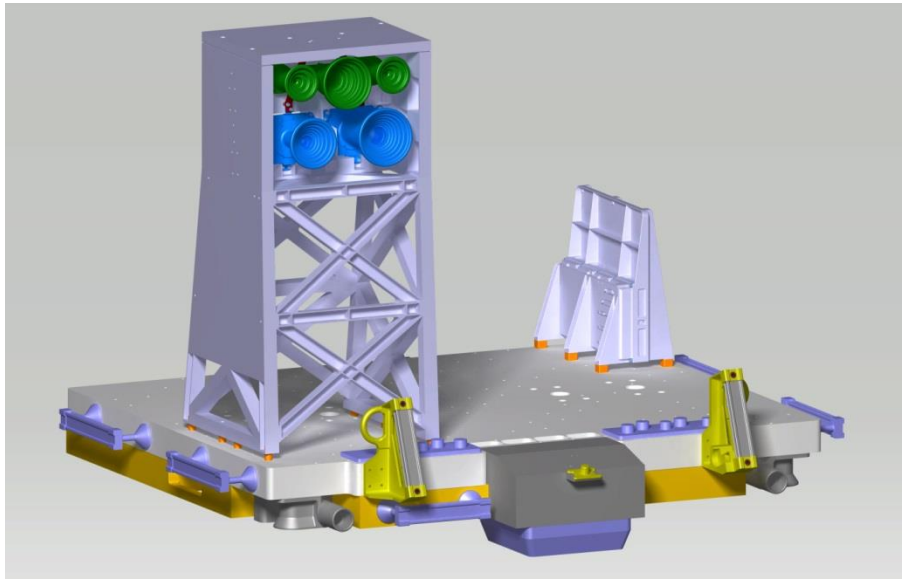
MMIA photometer



MMIA camera

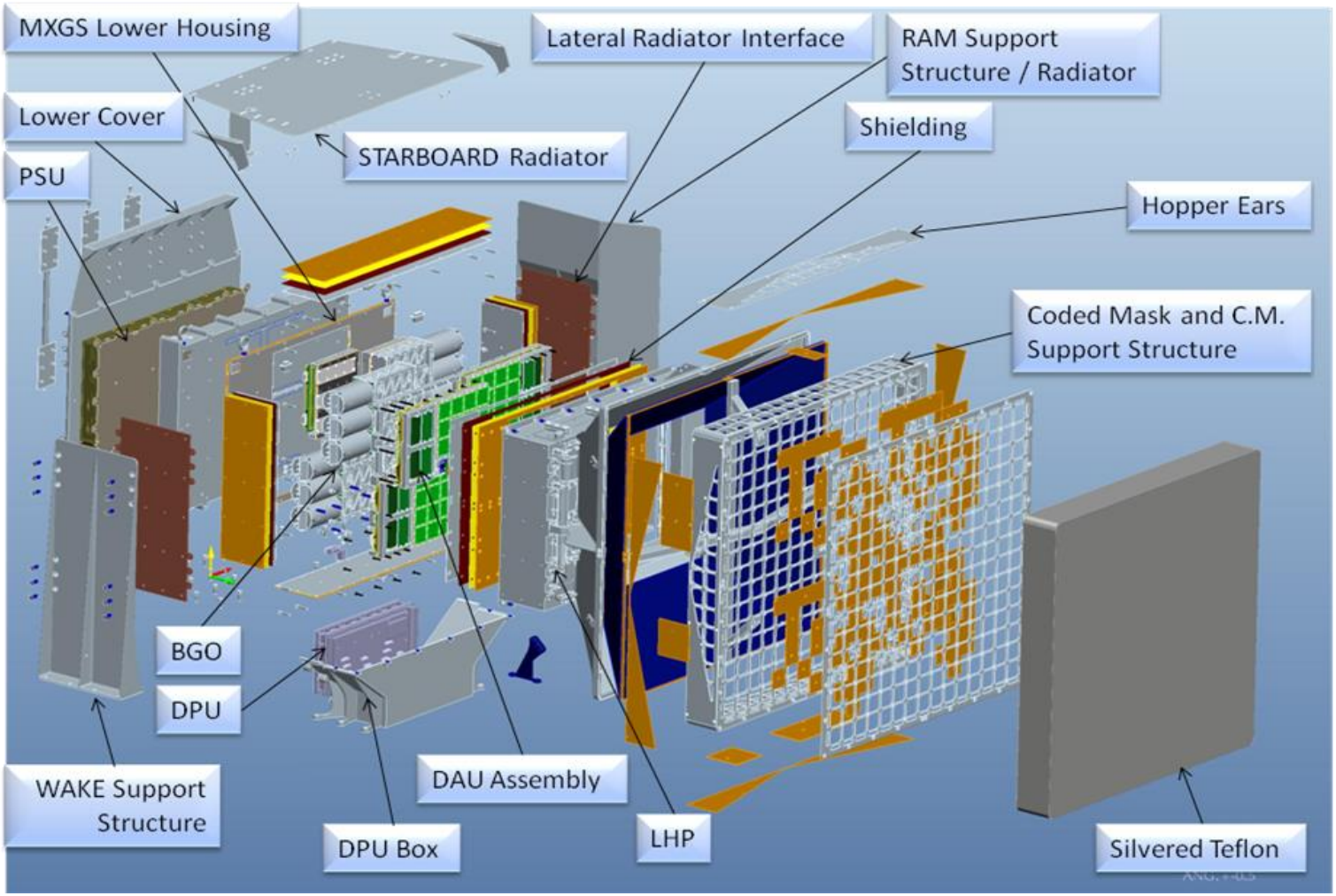
MMIA in numbers

- Envelope: 80.3 x 38.0 x 34.5 cm
- Vægt: 17.2 kg
- Power: 18.7 W + 20 W heaters
- Data rate: 17 kbps



MMIA on the CEPA

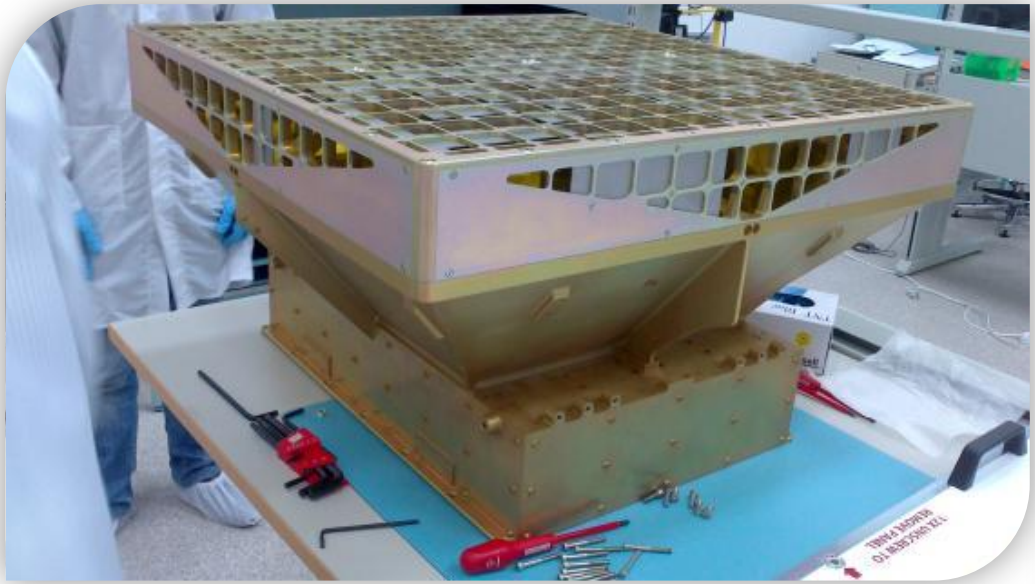
MXGS Exploded View



MXGS Specifications	
Energy range	LED: 15 - 400 keV HED: 0.2 -20 MeV
Energy resolution	LED: <10% @ 60 keV HED: <15% @ 662 keV
Quantum efficiency	LED: >0.94 @ 100keV HED: >0.60 E> 1 MeV
Relative time accuracy	< 5 μs
Burst rate capability	LED: >350 cts/ms HED: >650 cts/ms
TGF sensitivity (RHESSI mean TGF spectrum)	LED: S/N > 7 HED: S/N >15
Instrument background	LED: 2.4 cts/ms HED: 2.0 cts/ms
Trigger	Bi-directional link to MMIA
Auroral events – peak rate	10^6-10^7 cts/s for a few minutes
Mounting	Nadir-pointing
Fully Coded Field of View	LED: 80^O x 80^O HED: N/A
Location accuracy (STD error circle) (RHESSI mean TGF spectrum)	Point source: < 0.7^O 3^O diffuse source: <3.0^O

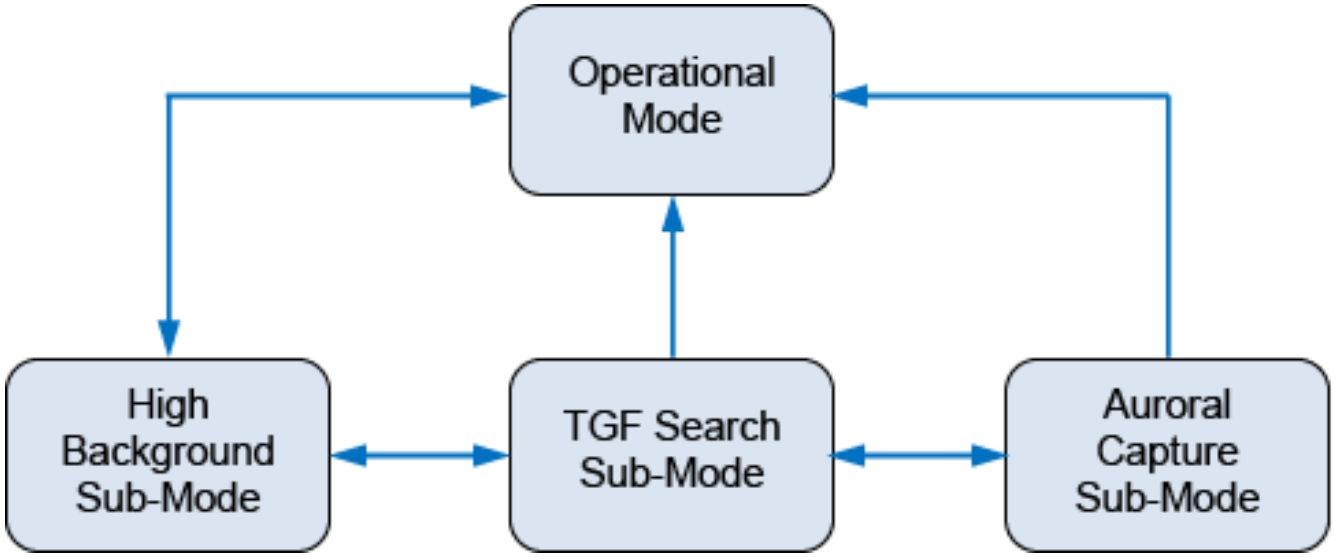
MXGS in numbers

- Envelope: 51.8 x 74.6 x 76.8 cm
- Vægt: 138.6 kg
- Power: 107 W
- Data rate: 12 kbs



MXGS Structural-thermal model at INTA, Madrid

MXGS data modes



MXGS science modes

- TGF Search Sub-Mode
  - Used in low detector background situations where data relevant to primary science objectives are being collected
  - TGF search algorithms are enabled
  - Monitoring functions of background rates, detector count sampling, accumulation of spectrally-binned data and time-binned data, are enabled.
- High Background Sub-Mode
  - Entered in high background situations (*e.g*. SAA passages)
  - TGF search algorithms are disabled and monitoring functions are enabled
  - If the background increases further, the detector enters a grey mode where only a fraction of detector events are recorded, to maintain DPU loading below 75%
  - At very high background levels, data communication to the DPU may be disabled completely.
- Auroral Capture Sub-Mode
  - Entered in high background situations, outside SAA passages, where data relevant to secondary science objectives are being collected, e.g. Auroral and REP events.
  - Identical to High Background Sub-Mode except that when the detector background rate exceeds a configurable threshold, high time resolution histograms are collected directly from address-mapped registers in the RCUs

ASIM Status

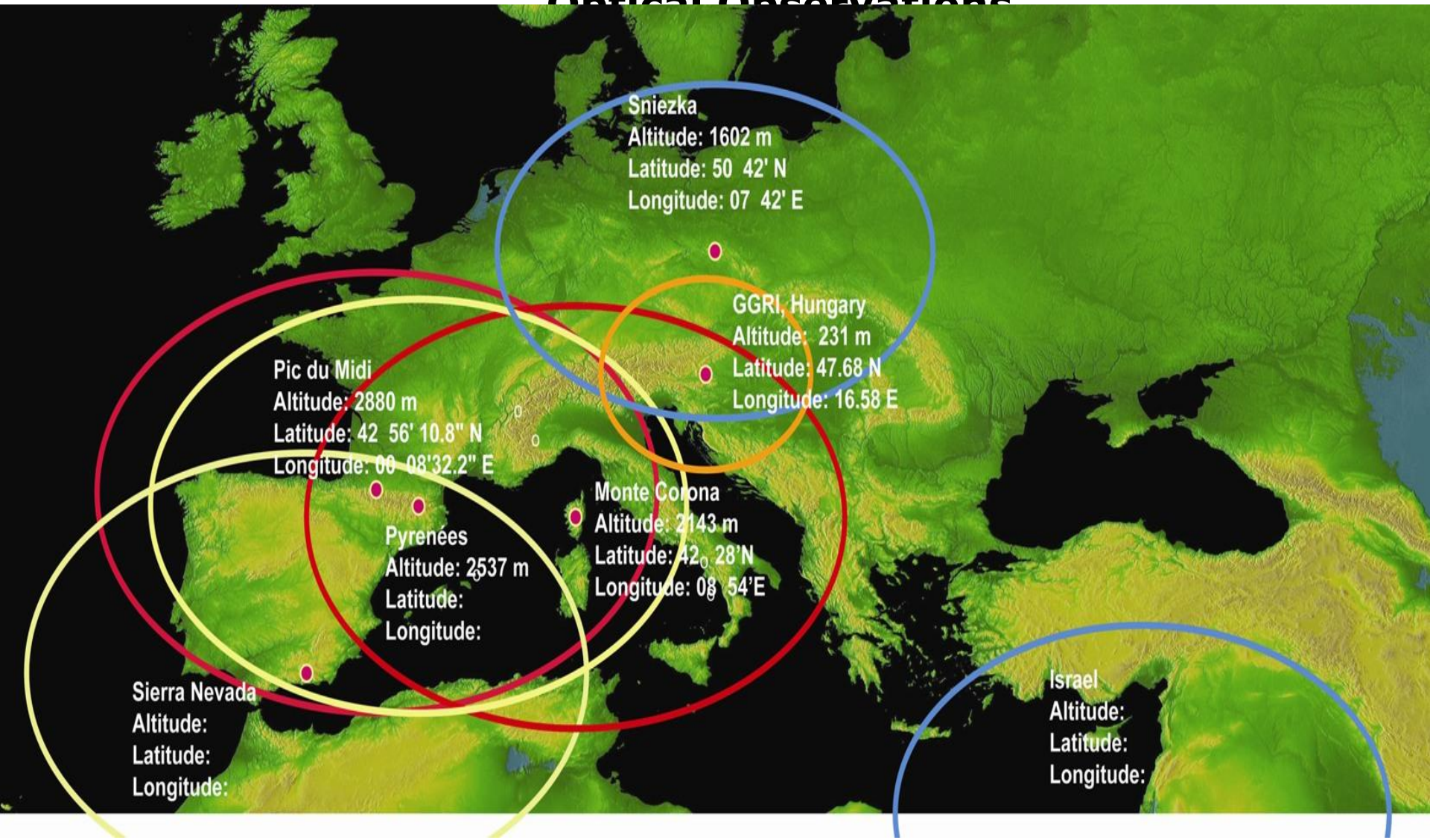
- Critical design review finished May 2014
- PFM Delivery to ESA summer 2015
- Launch 12th May 2016
- In orbit for a minimum of 2 years

The ASIM Consortium

- MMIA
  - Terma
    - DTU Space
- MXGS
  - DTU Space
    - University of Bergen
    - Space Research Institute, Poland
    - University of Valencia
- Instrument computers
  - DTU Space
    - Terma
- Payload computer
  - Carlo Gavvazzi, Italy

- Facility Science Team
  - Torsten Neubert (DTU Space)
  - Elisabeth Blanc (CEA)
  - Victor Reglero (University of Valencia)
  - Nikolai Østgaard (University of Norway)
- ASIM International Science Team of 80 groups from 30 countries
  - Including Italy

Optical Observations



The Giant of the Mediterranean
--- with a sprite ---

Van der Velde et al., 2010

Thank You